

IV. Part of a Letter from Mr Antony Van Leeuwenhoek, concerning the Worms in Sheeps Livers, Gnats, and Animalcula in the Excrements of Frogs.

I Have thought fit to confider of the Animals, our Butchers call Maggots, which often are found in the Livers of Sheep, when we have wet Summers.

When the Sheep have filled themselves with Water wherein these Animals were, they being carried with their food, out of the stomach into the beginning of the guts, where the bladder of gall doth empty itself, these animals being pleased with the taste of the gall, swim against it into the bladder of gall, and from thence go on into the vessels (like veins and arteries) of the gall; for when, a good while ago, I did search the liver of a Sheep, in the vessels whereof were many of these animals, and did open a nodous part of the liver, I did fetch out of a gall vessel one of these animals, which was twice as long in the vein, and was indifferent small.

When I had discovered this, I did fancy that the worm had forced herself into the small vessel, so that it could not get back again, and therefore did dye, which had first caused a corruption in that part; and secondly, the vein being stopt up by the worm did cause a second putrification and matter.

To discover (if possible) the said animals in the water, I did go in *August* in the year 1698 into several pasture grounds about this City, where Sheep did feed that were troubled with these diseases, and there I had some water taken up in a clear Glass out of the ditches

ditches and moats where the water was low, which I did examine and look upon with a more than ordinary Magnifying-Glass, and did observe that several sorts of animals did swim in the water. The water which I did not like I did fling away, and that which pleased me I did powr into a Glass Bottle.

The greatest sort of animals were these that produce Gnats, which carry their stings, wherewith they annoy both Men and Beasts.

One sort of these animals did generally sink to the bottom as soon as they ceased to move their bodies; and when by moving of their body they came to touch the surface of the water with any part that stuck out, then their head did hang down, and they did remain hanging on the surface of the water.

The second sort of these animals could not remain at the bottom, but generally were carried towards the surface of the water, and there they remained hanging, by two horns that came out of the upper body, on the surface of the water; and when they would go to the ground, they did make with their body a strong and vehement motion, whereto they made use of an instrument that was transparent, and was fixed on the end of the tail.

When I saw these differences in the said animals, I did consider, that, as there is several sorts of Gnats, that two sorts of Gnats did proceed out of these animals, *viz.* Gnats that have stings, and Gnats that have none; yet I found my self mistaken in my opinion, for I found that although there was two sorts of Gnats, yet they both had stings.

Out of these said Worms came Gnats from time to time, which did place themselves on the glass, and sat also down sometimes upon the water; and when they did so, they spread out their long legs on the water.

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This water I had ordered to be taken out of the ditches, on the 30th day of *August*; and when I came home, and was busie with viewing the multiplicity of these very small animals, that come through the water, and that of several sorts, I saw very many great round particles, of the bigness of a great corn of sand drive and move in the water.

When I brought these particles before the Magnifying-glass, I did not only see that they were round, but that the outward skin of them was quite set over with many protuberant parts, which did seem to me to be triangular, and pointed towards the end; so that it seemed to me, that in the great circle of the roundness, stood such particles, all orderly and equally from each other; so that on a small body did stand about two thousand of the before-mentioned convex or protuberant particles.

This was to me a very pleasant sight, because the said particles, as often as I did look on them, did never lye still, and that their motion did proceed from their turning round; and that the more, because I did fancy at first that they were small animals, and the smaller these particles were, the greener was their colour; and on the contrary, in the greatest, that were as big as a great corn of sand, there was no green colour at all to be discerned on the outside.

These particles had each of them within included 5, 6, 7, nay, some to 12 small round globules, of the same shape as the body was wherein they were included.

Amongst the rest, I did observe one of the greatest round parts somewhat larger, in a small quantity of water, before my eyes, and did perceive that the outward part began to open, and that one of the round particles that was within it, and was of a delicate green colour, did slip out of it, and began to move in the

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water, as that part had done whereout it did come.

After this time did the first round particle remain without any motion at all, and within a small time after did the second and the third part slip also out one after the other, and so did by degrees all come out after one another.

After the space of some days, the first round particle, as it was, united again with the water, for I could perceive no sign of it.

And what did also seem very strange to me was, that in all the motions I did see in the first round particle, I could not observe that the particles within did in the least change their place, altho the particles never came to touch each other, but did remain equally distant.

Most that should see these particles move in the water, would swear that they were live creatures; and that chiefly, if they did see them tumble about from one side to the other.

Now as there was a great many of the said round particles in one glass, wherein were also a great many living creatures, I did observe that in three days time they were all gone, so that I could see nor discern none of the said particles in the glass.

Moreover, I had a glass tube, of about eight inches long, as Fig. 4. A B, and of the thickness of a Goose Quill, wherein I had put some drops of water, as C D sheweth.

I left one end at A open, and the other end B I did stop up with a piece of Cork, so that between D and B was nothing but air, that the water might not run out of the tube when I came to handle it.

The air being shut up in the tube, between D and B, it cannot remain in the same bigness or magnitude, or expansion, but doth change, as one may say, every moment; for you cannot come near that tube, with your hand, breath, or any part of the body, that is a little

little warmer than the air, wherein the tube is, but the air in the tube is also extended, and more magnified thereby, which doth put the water into a motion, and is forced from D to A, although we perceive no motion with our naked eye.

Now as the least warmth doth extend the air, that is included in the lesser tube, so the warmth is also easily gone again from the tube, whereby the water doth receive a motion again, from C to B.

In this water were two of the said small round particles, and that of the greatest sort; and in each of them were included five smaller round particles, which inclosed particles were pretty well grown in bigness, and in a third great particle were lying seven lesser round particles, which last were incomparable small.

After the expiration of four days since the named particles had been put into the said tube, I saw that two of the same, the outmost skins, which were extraordinary thin and transparent, were broke in pieces; and that the ten particles, that had been shut up, in the two great ones, by the moving of the water were moved from one side to the other.

I observed further, that, after the expiration of five days, the small particles, that were included in the third great particle, were not only increased in bigness, but I could also then discern that from the inside of the small particles should come forth round small particles.

After the expiration of five days more, the third round particle was also a little broke open, and the particles that did lye there within were also got out, and although it was open at one side, yet did it turn about in the water, and that as nimbly as ever it had done before.

Some days after I could not discern any, but only some small particles, whereof the great one did con-

list, which also in a little while did vanish. I did never miss a day, but did look upon the small particles that came out of the greater one, and did observe that they did not only increase in bigness, but that the inclosed particles did also grow bigger.

In the latter end of *September*, I perceived that the inclosed particles were not so exactly round, as the great ones that included them ; and also that some of them were protuberant, and that the last particles that were come out of the great ones, not being round, did lye against the side of the glass without motion.

Now the last greater particles, when they were discharged of their inclosed particles, or were broke in pieces, were about four times less than these that were come forth from them ; wherefore I must conclude that they had not their full growth, or not their full food.

I have also observed, that the said round particles are of an equal weight with the water, and this being, they may by the least motion the water receiveth by the air, also be put into motion.

I thought convenient to get drawn one such before-mentioned particle, with the particles inclosed within it, as fig. 5. by E. F. sheweth. In which part, the included round particles (that were increased so much, in bigness, that they were ready to be flung out) did not lye in order so well in the before-mentioned, as in this lately named, where was not such an ordinary motion, which made me believe that this was only caused because the inclosed particles did not all lye equally distant from their center, and that these that did lye furthest from the center, did make the one side of the round particle heavier, which did hinder the motion.

To what purpose these round particles are created is unknown to us. When I did perceive, that the manyfold round particles, that were in the great Glass, were mixt with a great number of small animals, were gone in three days time, I did consider whether these

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particles were not created as food for these animals

Now when we see, that the oft before mentioned round particles do not proceed from themselves, but by procreation; as we know that all plants and seeds are procreated, viz. that in each seed, be it never so small; yet it has its plant inclosed within it, we can assure ourselves more than before concerning procreation of all things. As to me, I put down as a certain truth, that the small round particles that are found in the great ones are seeds, and that without them the round particles could not be made.

I have this Summer several times been about the waters near our Town, to examine them, and the last time was the 8th of October 1699. but I could never satisfy myself more.

I saw at the same time a small Frog leaping, which I did judge had been an egg the last spring, which I caused to be caught, and when I came home I did place it in a tube of glass, which was an inch wide and ten inches long, and did stop both the ends up with cork, yet after such a manner, that at one end the air could go out and in.

I did view the toes of the fore-legs by the help of a Magnifying-glass, to see the circulation of the blood, which I could not but with great difficulty discern.

But when I came to look upon the hindmost Legs, and did look upon the skins that are between the toes, which are on purpose to swim withal, as we see in all the feet of Water-birds, I saw in a great many veins that were very small the blood circulate, which did please me so well, that I did look upon it for several days successively.

I did also observe, that when the Frog was putting out its Leg, that thereby the circulation of the blood was stoppt for a small time; but as soon as it stood still again, the blood began to circulate again. When I saw this, I did imagin, that when this Animal did thrust its
Legs

Legs against the Glas, to climb up, that then the blood Vessels were thereby pressed, and so the circulation hindered.

After this Frog had been put up about 24 hours in this tube, I saw its excrements in a place, as it were on a heap. After it had been there twice 24 hours it had foul'd again, then I did look upon the excrements with a Magnifying-glass; in the first excrement I saw that it had made use for its food of an animal whose body was beset with hair of several thickneses, which were very sharp pointed, which I did judge to be of some flying animal: When I did look upon the second excrement, I saw no hair in the beginning: these excrements did lye in a clear moisture, that was round about them, wherein did swim or creep some Eels, or about 30 small Worms, the fore part of their body and also the hinder part were very clear.

I have formerly said, that I did open the small Eels which we did find in Vinegar, and did take out of them some young Eels.

These Eels of the excrement of the Frogs, are very like the before-named ones, if not altogether the same, only with this difference, that the Eels of the Vinegar, as they come out of their Mother's Womb are somewhat thinner and harder.

In the first excrement I discover'd only two of these Eels.

The second excrement I did lay asunder, then I did not only see some hair, but also a piece of a foot, part of the eye, a piece of a wing, and many pieces of the skin of an animal, which I judged to have been a small creature, whose wings are covered with a sheath, very like those we call beetles.

When I did look the next day, and saw that the moisture wherein the small Eels did swim, was partly evaporated, and that the Eels did move but very little, I put a little rain water round about the excrements

ments wherein all the Worms and Eels were, that they might be in more moisture; then I put the moisture into a small glass tube wherein were six Eels, thinking to keep them alive, and to observe whether they would breed any young ones.

Yet I found the contrary; for they did move less, and within a few hours after some were quite without motion; and the other day I saw, after an exact examination, only one part of an Eel lye so that I could find no likeness of an Eel, wherefore I must conclude that the Eels were dissolved in the water, so that there did remain only some stuff, without any figure or form.

The Frog had so moved about in the glass tube, that he had separated the dung he had made first, whereby I came to see almost a whole wing of a flying creature, having been about the bigness of a Gnat, and this was almost quite whole, so that I could see perfectly the great number of small hairs which did grow all over the outside, and also upon the edge of the wing.

Underneath this wing I saw three of the said Eels, and another in another place, that had still a strong motion in them.

On the fourth day after the excrements had been made, I saw some as well above as under the wing, being alive, and being that the moisture wherein they did lye was but very little, so was their motion but little, and afterward I could perceive no motion at all.

From these observations we may very well conclude, that the water was not proper for these Eels, but that they are come out of the ground, or that the animals whereof the Frog made use of for its food, were loaded with them.

On the fifth day the Frog had dung'd again, and it did lye oblong against the glass, without any moisture at all.

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I took it out of the glass, and spread it abroad, because it was blacker to the eye than the before-mentioned, and did see that there were also part of flying animals, and among this stuff did also lye several of the before-mentioned Eels, but they were all dead, and somewhat less than the former.

Further, I had put the Frog in a glass with water, whereout it made its escape, and got away.

Delft, Jan. 2. 1700.

V. An Account of the Houses and Hearths in Dublin, for the years following. Communicated by Captain South.

Houses.		Good.	Poor.	Wast.	Total.
January 169 $\frac{1}{2}$.	—————	4665	485	849	5999
169 $\frac{6}{7}$.	—————	4905	502	717	6124
Hearths.					
January 169 $\frac{1}{2}$.	—————	24402	1080	3439	29220
169 $\frac{6}{7}$.	—————	25366	1227	2627	29519

In the total of Hearths there are included 229 which are in Colledges, &c. and are not reckon'd in the three first Columns.

Fig. 2

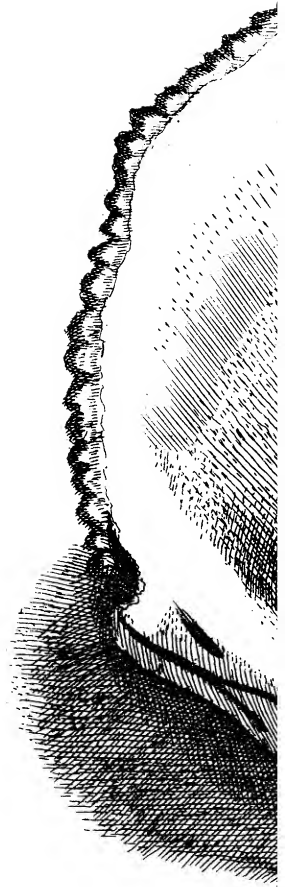
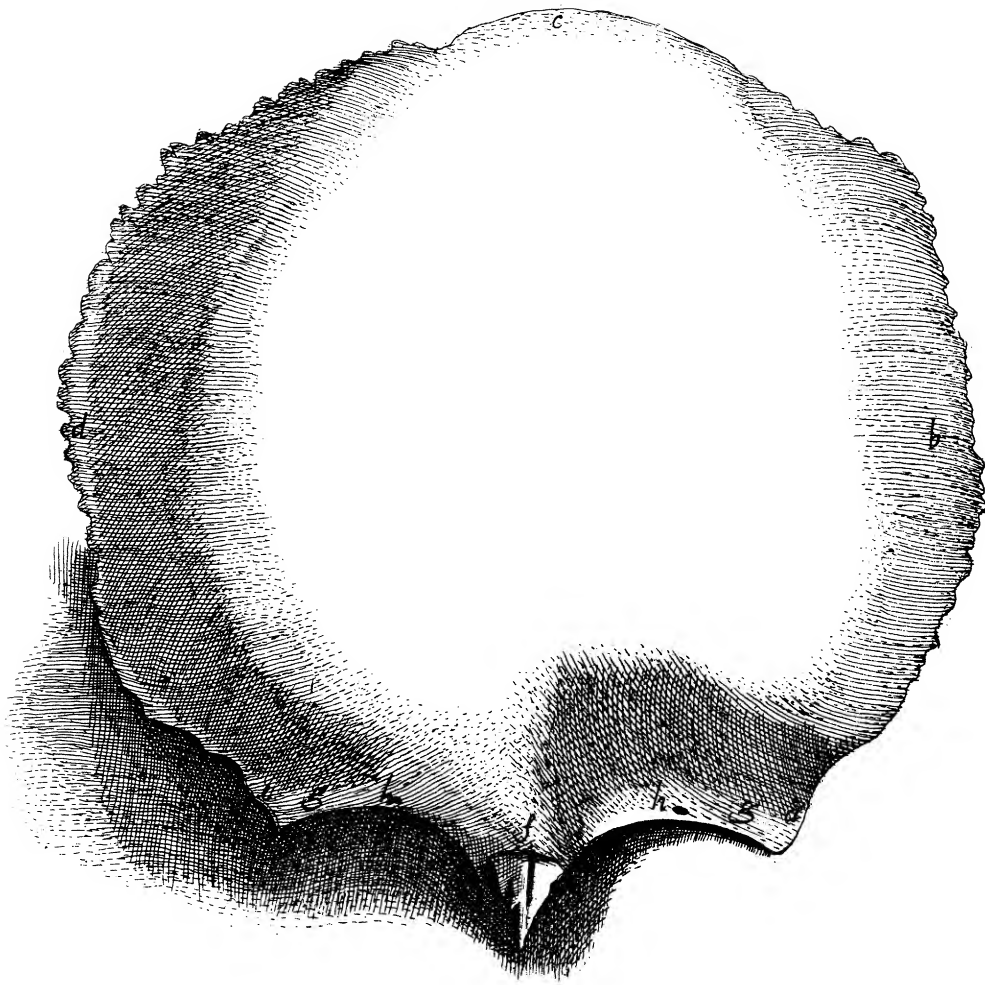


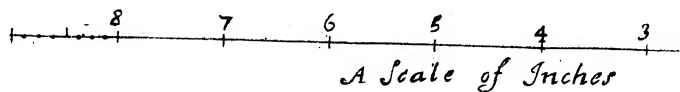
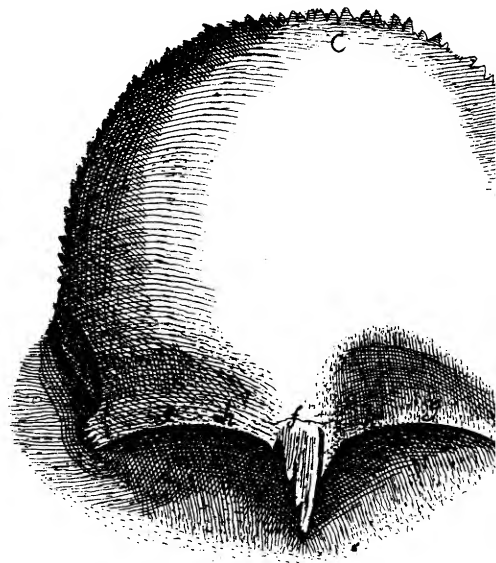
Fig : 3



Fig : 4



Fig : i



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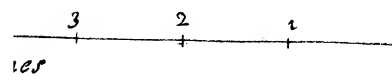
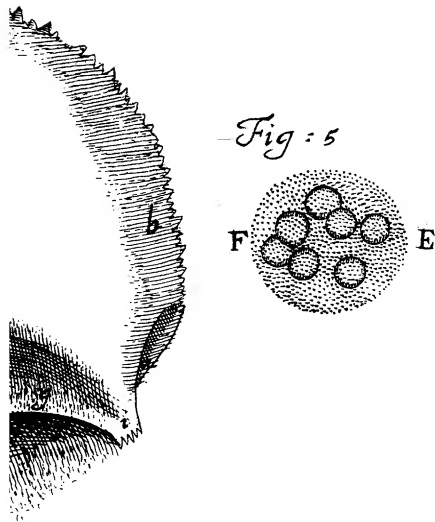
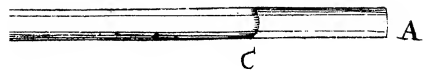


Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5

